

Considering a Real World Problem Topic 1

What's the Connection Between Carbon and Climate?

Carbon is contained in most living organisms, as part of proteins, carbohydrates and fats. Heterotrophic organisms release carbon dioxide when they respire. Autotrophs, including plants, use and release carbon dioxide in photosynthesis and respiration although they use and store more carbon than they respire. When organisms die, bacteria and decomposers break down the organic carbon molecules and release the carbon atoms as carbon dioxide. Carbon, in its various chemical forms, naturally cycles through the atmosphere, the terrestrial biosphere and the oceans, three components that are commonly referred to as carbon 'reservoirs'. Forests store carbon in vegetation, detritus, soil, black carbon residue from fire and harvestable products (Schulze et al., 2000). Carbon is difficult to quantify since so many organisms and materials contain carbon in the world, in a biome, an ecosystem or a single habitat.

Figure 1 below shows a representation of the global carbon cycle. It shows that some carbon is stored in Earth's reservoirs and some carbon is always flowing between and within three reservoirs, the atmosphere, the ocean and the land.

Figure 1: Diagram of the Carbon Cycle

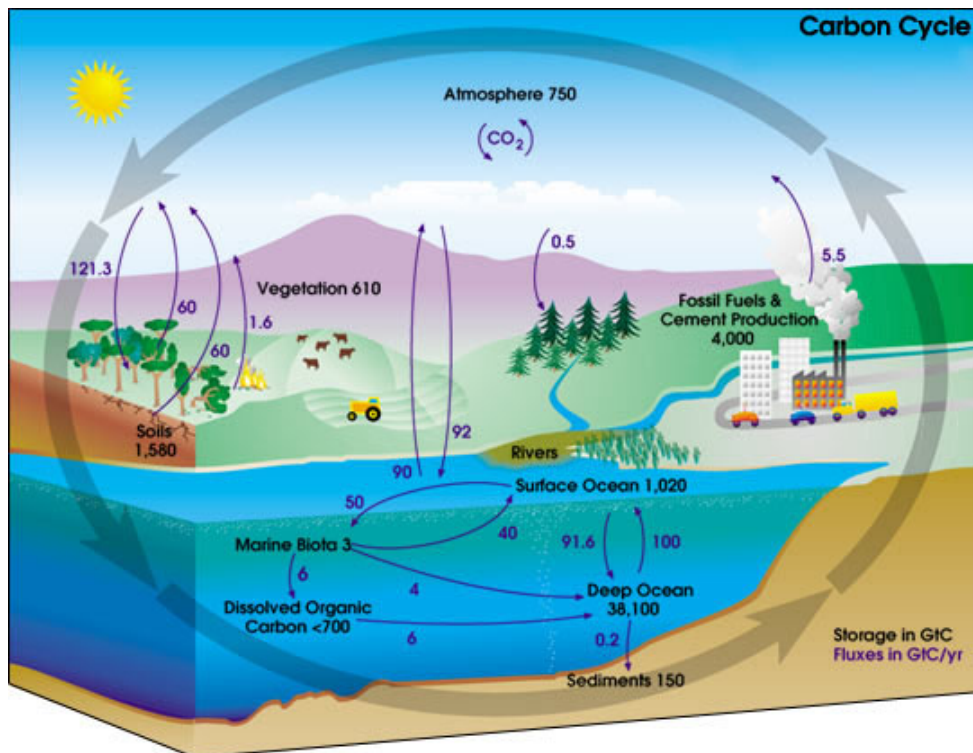


Image from: http://earthobservatory.nasa.gov/Library/CarbonCycle/carbon_cycle4.html, Courtesy of NASA Earth Science Enterprise.

Different tree species and soil types hold different amounts of carbon. They also decompose at different rates. Decomposition, carried out by various microbes, results in the release of carbon to the atmosphere. The microbes respire as we do, taking in oxygen and releasing carbon dioxide. So, understanding the terrestrial carbon reservoir means that we have to understand what is growing on Earth today as well as how fast it will decay and, through microbial decomposition, how fast the carbon held in trees and soils will return to the atmosphere in the future.

Carbon dioxide, water vapor, nitrous oxide, methane and certain other carbon-based molecules are considered to be Greenhouse Gases. This means that they exist in the atmosphere and allow energy from the sun to pass through the atmosphere and warm the Earth's surface but they trap energy that is re-emitted from the Earth. The gases re-release the energy back toward the Earth, thereby warming the surface. This is known as the Greenhouse Effect. Carbon and other Greenhouse Gases in the atmosphere help to keep the temperature of the planet's surface warm enough to support abundant life.

Plants are just one example of organisms that need a warm atmosphere in order to grow. Under favorable conditions (sufficient light, water and nutrients), plants photosynthesize. They use energy from the sun and water and carbon dioxide to manufacture sugars and oxygen. Therefore, photosynthetic organisms remove carbon dioxide from the atmosphere and help to keep the carbon budget in balance.

The Earth system and the many ecosystems it supports are sensitive systems. That means that a change in one component of the system, whether it is biotic or abiotic, has an impact on other components of the system. A small perturbation in atmospheric carbon is not an isolated event and it may have long-range and large-scale impacts.

How might changes in climate impact the world's biomes and the diversity of living organisms that exists on our planet?

How might climate change influence the stability of our ecosystems and planetary habitability?

Culminating Essay for Topic 1: Ecosystems

At the conclusion of Topic 1 investigations, write a 500 word essay that responds to the two questions shown directly above. Consider what you learned about ecosystems and biomes. Use these understandings and your investigation findings to justify your responses.